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Organic Nanoscale Materials for Energy and Charge Transfer

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The development of efficient artificial systems for solar energy conversion is essential for creating a sustainable energy source. Natural photosynthesis relies upon non-covalent interactions between chromophores to regulate the direction, yield, and rate of energy and electron flow. In order to create solar materials, we employ bio-inspired molecular designs based on self assembly of organic chromophores that are economical and versatile yet sufficient to mimic the functionality of the natural system. Small-angle and wide-angle x-ray scattering (SAXS/WAXS) experiments are used to elucidate aggregate structures in solution. Coupled with transient optical spectroscopy and electron paramagnetic resonance spectroscopy, these data allow correlation between supermolecular structures and photophysical properties of chromophores studied.

For example, perylene-3, 4-dicarboximide (PMI) was covalently linked to melamine (Mel) through a two-phenyl spacer and shown to form large-scale aggregates through hydrogen bonding, pi stacking, and microsegregation. SAXS/WAXS results in methylcyclohexane indicate that the observed aggregation is the formation of multi-(PMI-Mel)subunit cylindrical structure. Optical experiments further support large-scale structural aggregation through the observance electron transfer (ET) from Mel to PMI as seen only in aggregating solvents (i.e. MCH). No ET is observed when PMI-Mel is assumed to be in its monomeric form, indicating that aggregate ET is likely intermolecular.